



# ReFUEL Laboratory

Center for Transportation Technologies and Systems • National Renewable Energy Laboratory



## Renewable Fuels and Lubricants (ReFUEL) Laboratory

The ReFUEL lab is a world-class research and testing facility dedicated to future fuels and advanced heavy-duty vehicle research, located in Denver, Colorado. The lab features a chassis dynamometer for vehicle performance and emissions research, an engine dynamometer test cell capable of certification-quality emissions testing, and a fuel chemistry laboratory for performing precise studies of fuel properties, including ignition quality. The emissions measurement systems for vehicle and engine testing meet or exceed the requirements of the 2007 Code of Federal Regulations (CFR), a significant step above current requirements, allowing for accurate testing of very clean modern and future engines and vehicles, with or without aftertreatment. The ReFUEL lab is the first independent laboratory in the United States with a heavy-duty chassis dynamometer that is capable of meeting the 2007 CFR emissions measurement standards. The lab is equipped with the extensive capabilities and resources to provide high quality data and research leadership in a variety of advanced and future technologies including advanced fuels, heavy hybrids, and clean diesel. The ReFUEL lab is funded by the U.S. Department of Energy, Office of FreedomCAR and Vehicle Technologies.

### CHASSIS DYNAMOMETER

- Inertial simulation range: 8000 – 80,000 lb (vehicle classes 3-8)
- Grade simulation and optional dynamometer-assisted braking
- Hydraulic hitch loading system
- Tandem axle, 40" rolls
- Programmable driver aid

### ENGINE DYNAMOMETER

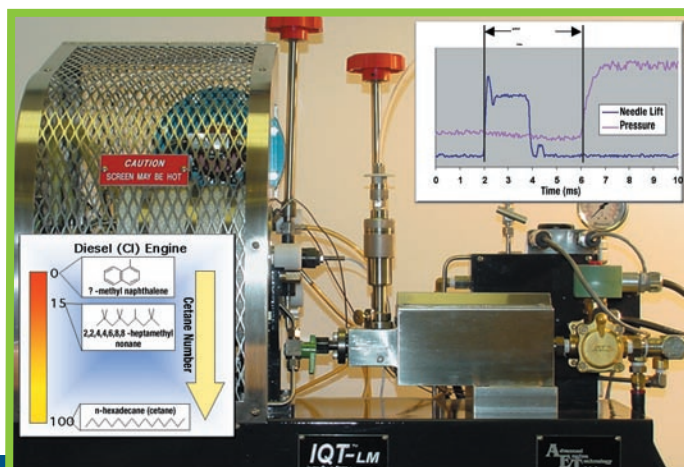
- 400 hp DC-electric motor
- Advanced Controls Capability: Transient Federal Test Procedures (FTP)

### EMISSIONS MEASUREMENT

- Compliant with 2007 Code of Federal Regulations (CFR)
- Continuous measurement of emissions: NO<sub>x</sub>, HC, CO, CO<sub>2</sub>
- Particulate Matter (PM) measurement
  - 2007-compliant filter media and holders
  - Ultra-micro balance: 0.1 µg readability
  - Class 1000 clean room / environmental chamber
  - Active vibration and static mitigation
- Additional, unregulated emissions measurements:
  - Carbonyls, Aldehydes, and Ketones
  - Hydrocarbon Speciation (C<sub>1</sub> -C<sub>12</sub>)



Clockwise, from top left: Class 8 truck installed on chassis dynamometer, technician preparing to drive a test on chassis dynamometer, engine test cell configured for biodiesel research using state-of-the-art production diesel engine, and engineer performing quality assurance tests on emissions analyzers.



The ReFUEL-16 Fuel Chemistry Laboratory, which features an Ignition Quality Tester (IQT), was launched in January, 2003. The IQT is being used to measure and correlate molecular structure with ignition properties of renewable fuels and blending components.



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## ADDITIONAL LAB FEATURES AND CAPABILITIES

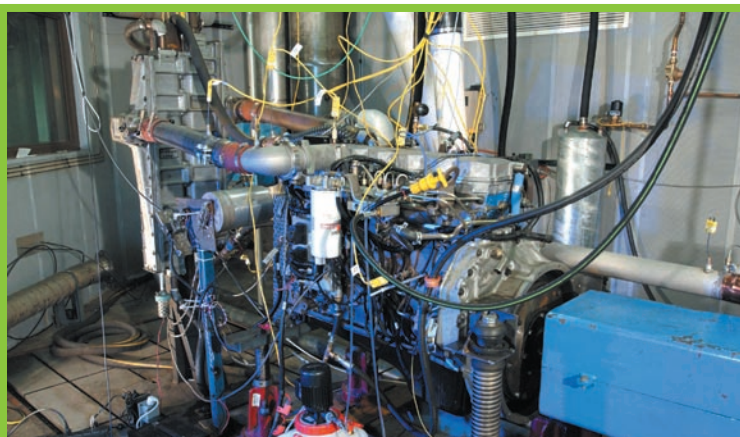
- Power analyzer for voltage and current measurements (i.e. battery pack state of charge) to support heavy hybrid research
- Combustion analysis, including high speed data acquisition of line pressure, needle lift, and in-cylinder pressure
- On-site temperature controlled fuel storage (48 drum) and high-accuracy drum quantity fuel blending
- Continuous fuel flow metering ( $\pm 0.5\%$  reading accuracy), in-line density measurement, fuel temperature control
- Conditioned and filtered (HEPA) combustion and dilution air with high-accuracy combustion inlet air flow measurement (laminated flow element)
- Full scale exhaust dilution tunnel (selectable flow range 500 – 3000 scfm, via parallel critical flow venturis)
- Altitude simulation to sea level conditions (Lab is at an altitude of approximately 5,280 ft)
- Ignition Quality Tester (IQT) for measuring fuel cetane number/ignition delay



Hydraulically actuated hitch load system during development



Engineer monitoring chassis dynamometer controls and data acquisition



State-of-the-art production engine instrumented to study biodiesel and synthetic diesel fuels



Clean particulate matter filter being weighed in preparation for testing

Photos by Warren Gretz. NREL/PIX 13288, 13270, 13269, 13276, 13285, 13275, 13292, 13290, 13269


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